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(19)

(54) MAGNESIUM-BASED ALLOY

(71) We, NINA MIKHAILOVNA TIKHOVA, of kvartira 394, Frunzenskaya naberezhnaya 38/1, VALENTINA ALEXEEVNA BLOKHINA, of kvartira 25, korpus 3, 15 Parkovaya ulitsa 42, ANTONINA PETROVNA ANTIPOVA, of kvartira, 19, Sheremetievskaya ulitsa 71a, and TAMARA PAVLOVNA VASILIEVA, of kvartira 5, Izmailovsky bulvar 46, all Moscow, Union of Soviet Socialist Republics, all citizens of the Union of Soviet Socialist Republics, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to magnesium-based light structural alloys, particularly those for the production of parts subject to heating in service.

Widely known are magnesium thorium alloys of the following grades: Grade HK 31 containing the following components, in weight per cent: 2.5 to 4.0 thorium, 0.4 to 1.0 zirconium, at least 0.3 zinc, and magnesium as the balance; and HZ 32 — alloys containing in weight per cent: 2.5 to 4.0 thorium, 0.5 to 1:0 zirconium, 1.7 to 2.5 zinc, and magnesium as the balance.

However, because of the radiological toxicity of thorium, the production of these alloys is detrimental to the health of the persons exposed, and requires the construction of specialized sections and shops.

Also known is an alloy doped with yttrium (US Patent No. 3419385) containing the following components, in weight per cent: 4.8 yttrium, 2.1 zinc, 0.7 zirconium, and magnesium as the balance. However, this alloy has rather poor mechanical properties and contains a large amount of the expensive metal yttrium.

The present invention provides a magnesium-based alloy containing in weight per cent: 0.8 to 6.0 yttrium, 0.5 to 4.0 neodymium, 0.1 to 2.2 zinc, 0.31 to 1.1 zirconium, up to 0.05 copper, up to 0.2 manganese, and magnesium as the balance.

Due to the presence of yttrium, neodymium, and zinc, the alloy exhibits a favourable combination of high creep resistance and strength, which is attributable to the doping of the solid solution and the formation of intermetallic compounds having improved thermal stability.

The dopant, zirconium, being efficient for the formation of a fine-grained structure, contributes not only to enhancement of mechanical properties in respect of short-term stress but to substantial improvement in technological casting properties of the alloy.

As compared with the available high-temperature magnesium alloys, the composition of the inventive alloy does not incorporate thorium, which is toxic radiologically.

The mechanical properties of the inventive alloy, as against those of the known alloys, are given in Table I.

TABLE 1

	20°C			300°C				400°C		
	$\sigma_{0 \cdot 2}$	σ_6	δ_5	$\sigma_{0 \cdot 2}$	σ_6	δ_5	$\sigma_{0 \cdot 2/100}$	$\sigma_{0 \cdot 2}$	σ_6	δ_5
	kg/mm²		%	kg/mm²		%	kg/mm²	kg/mm²		%
Inventive alloy	12	22	4	10	15	10	3.5	5	8	20
HK 31	9	19	4	7	13.5	10	2.3	3.5	6.5	20
HZ 32	9	19	6	4.2	7.7	20	3.7	3	6	30
Alloy of U.S. Patent No. 3419385, containing 4.8% Y, 2.1% Zn, 0.7% Zr	10.2	18.2	—	—	—	—	2.1 at 315°C	—	—	—

Where $\sigma_{0 \cdot 2}$ = yield point;

σ_6 = tensile strength;

δ_5 = elongation;

$\sigma_{0 \cdot 2/100}$ = creep strength.

It is evident from Table I, that as to the properties at room temperature, the alloy of the invention is superior to the known magnesium-thorium alloys in the tensile strength by 15% and in the yield point by 25%. At higher temperatures the proposed alloy combines the best properties of both known magnesium-thorium alloys. Thus, during short-term tensile-testing at a temperature of 300°C it surpasses the HK—Alloy by 30% and the HZ 32—Alloy by 2.5 times in the yield point, and in the tensile strength it is superior to the HK 31 Alloy by 10% and to the HZ Alloy by 2 times. When subjected to prolonged loading the creep stress of the herein-proposed alloy is similar to that of the HZ 32 Alloy, being by 1.5 times superior to the HK 31—Alloy.

EXAMPLE I.

The magnesium-based alloy contained (in weight per cent): 1.4 yttrium; 1.6 neodymium; 0.3 zinc; 0.6 zirconium; magnesium, the balance. This alloy was subjected to heat treatment which involved hardening by heating and subsequent cooling, in the air or in hot water, and ageing.

After the above heat-treatment the alloy had the following mechanical properties:

yield point	$\sigma_{0,2}$	12 kg/mm²
tensile strength	σ_6	26 kg/mm²
elongation	δ_5	6%
creep strength at 300°C	σ_{100}	6 kg/mm²

EXAMPLE 2.

An alloy containing (weight per cent) 2.2 yttrium; 2.3 neodymium, 0.6 zinc, 0.6 zirconium, and the balance magnesium, was subjected to the heat-treatment operations which involved hardening by heating and subsequent cooling, in the open air or in hot water, and ageing.

The alloy had the following mechanical properties:

yield point	$\sigma_{0,2}$	15 kg/mm²
tensile strength	σ_6	28—30 kg/mm²
elongation	δ_5	4%
creep strength at 300°C	σ_{100}	6.0— 6.5 kg/mm²
at 250°C	σ_{100}	11.5—13 kg/mm²
	$\sigma_{0,2/100}$	7.5— 8.5 kg/mm²
at 200°C	σ_{100}	18 kg/mm²
	$\sigma_{0.2/100}$	11.5 kg/mm²

EXAMPLE 3.

The alloy contained (in weight per cent): 4.0 yttrium, 0.5 neodymium, 2.0 zinc, 0.31 zirconium, and magnesium as the balance. This alloy was subjected to heat treatment involving hardening by heating with subsequent cooling, either in the air or in hot water, and ageing.

The mechanical properties of the alloy were as follows:

yield point	$\sigma_{0.2}$	11 kg/mm²
tensile strength	σ_0	18 kg/mm²
elongation	δ_5	3—6%
creep strength at 300°C	σ_{100}	6—7 kg/mm²

The magnesium-base alloy of the above-specified composition thus features excellent creep strength which is combined with high strength and processability.

The alloy composition does not incorporate radioactive or toxic dopants.

The alloy is advisable to be employed for the production of cast elements heated in operation to 300°C (continuously) and 400°C (intermittently).

The use of the proposed alloy instead of aluminium alloys and in some cases instead of titanium alloys contributes to a substantial reduction in weight.

WHAT WE CLAIM IS:—

1. A magnesium-based alloy containing, in weight per cent: 0.8 to 6.0 yttrium, 0.5 to 4.0 neodymium, 0.1 to 2.2 zinc, 0.31—1.1 zirconium, up to 0.05 cooper, up to 0.2 manganese, and magnesium as the balance.

2. An alloy according to any of Examples 1 to 3.

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